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ACCOUNTING FOR GOLD AND SILVER MINES: THE DEVELOPMENT OF COST ACCOUNTING

Abstract: This study found evidence which supports the thesis that cost accounting techniques evolved rapidly during the last quarter of the nineteenth century. The cost accounting system employed by the leading mines of the Comstock Lode during the 1870's is compared to a system used in the Cripple Creek district of Colorado during the first decade of the twentieth century. The cost accounting techniques of the mining industry appear to have developed rapidly during this period from crude to sophisticated systems.

Introduction

Littleton [1977, p. 340] stated that the bookkeeping texts of the first three quarters of the nineteenth century presented very inadequate cost accounting techniques. Garner [1976, p.67] maintained that developments in "industrial accounting were at a low ebb in the period 1840-75." It was only in the last quarter of the century that well organized cost systems were developed in response to an increasingly complex business environment. Chatfield [1977, p.160] expressed the following similar view: "Between 1885 and 1920 cost accounting evolved from a level where the methods used seem almost as remote as medieval bookkeeping, to a point where most of the descriptions in today's texts were approximated by the best practice." On the other hand Johnson [1972, p.469] found evidence of an elaborate fully integrated cost accounting system that was employed by a small textile mill prior to 1860. Johnson's research raises the question of whether industrial practice developed more quickly than Chatfield, Garner and Littleton have indicated. This is the issue addressed in this study.

In 1954 Garner [1976, p.69] declared that very little study had been made of the accounting records of nineteenth century industrial firms. Twenty years later Johnson [1972, p.466] expressed a similar opinion. Johnson [1972, p.468] argued that such studies are needed because this type of research provides the most reliable

evidence about the evolution of industrial management accounting practices. Since 1972 several accounting historians have directed their attention to this important area of research.

The account books and records of underground gold and silver mines provide an excellent opportunity to study the evolution of cost accounting procedures between 1870 and 1910. Mining played an important role in the development of America and particularly of the West. The California gold rush, the Alaska gold rush and the bonanzas of Nevada's Comstock Lode are leading examples of the importance of mining.

This study focuses on the accounting systems of the Consolidated Virginia Mining Company, the California Mining Company and the Portland Mining Company. The first two firms were the most successful mines on the Comstock Lode. These mines were quite active during the 1870's. Many of their account books have survived and can be found in the special collections of the University of Nevada Reno Library. The Portland Mine [Finlay, 1910, p.376] was the leading mine in the Cripple Creek district of Colorado during the first decade of the twentieth century. The accounting system of the Portland Mining Company is described in great detail by Charlton [1912, pp.275-316]. These firms were selected for a number of reasons including: the similarity of the nature and size of their operations, and the dates that they were actively mined.

In the following sections the cost accounting systems employed by the Comstock mines will be described and compared to the system used in the Portland Mine. These accounting systems are separated by approximately 30 to 40 years. According to Chatfield, Garner and Littleton it was during this period that American industry made great technical advances in the area of cost accounting. This thesis is supported by the evidence gathered during the current study of mine accounting. The Comstock mines used a primitive system for determining the cost of mining, whereas the cost accounting system of the Portland Mine was far more sophisticated. While this paper is not considered to be proof of the Chatfield thesis, it provides substantial support for this image of the evolution of cost accounting.

Some might argue that the mines selected for this study are not representative of their respective periods. Perhaps the Comstock mines were unusually backward or the Cripple Creek mine was unusually advanced. However the accounting system of the Portland Mining Company is described by Charlton as being representative of its industry in 1910, not as an unusually advanced system. The

California and Virginia mines were the leaders of the industry in the 1870's. These firms could afford the best laborers, managers and accountants. All of the evidence indicates that these two mines possessed accounting systems that were typical of the better managed firms of the era. This study shows the evolution that occurred in accounting for the nation's top mining operations.

The next section of this paper gives a history of the Comstock Lode and the Bonanza mines. This is followed by a brief discussion of mine accounting. Then the cost accounting systems of the Portland and Comstock mines are illustrated. With the advanced accounting system of the Portland Mine as a reference, the inadequacies of the cost system of the Comstock mines are more clearly seen.

History of Comstock

One of the most fascinating chapters in the history of the American West is the story of the Comstock Lode and Virginia City, Nevada. The Comstock Lode was the first large silver deposit found in the United States of America. It was discovered in 1859 by placer miners who had been working stream deposits in the Washoe district of Nevada since 1850. While many mines operated along the Comstock Lode during the 1860's and 1870's, the two greatest were the Consolidated Virginia Mining Company and the California Mining Company. These two firms held adjacent claims near the northern end of the Comstock. The legendary "Big Bonanza" ore body was situated entirely within these claims. During the years 1873 through 1881 the Big Bonanza yielded over one hundred million dollars in gold and silver bullion.

The Big Bonanza was extracted during the period from 1873 through 1881. The production for that period was as follows [Smith, 1943, pp.260-261]:

MINES	GOLD	SILVER
Consolidated Virginia	$29,168,227	$31,959,256
California	$23,395,270	$20,646,106
Totals	$52,563,497	$52,605,362

Over $74 million in dividends were paid from these revenues.

Eliot Lord [1883, p.311] gave the following description of the Big Bonanza: "No discovery which matches it has been made on this earth from the day when the first miner struck a ledge with his rude

pick until the present." Dan De Quille [1953, p.371] described it as the heart of the Comstock Lode while Shinn [1980, p.182] called it the "richest hoard of gold and silver that ever dazzled the eyes of a treasure-seeker." In most mines veins of precious metals range in thickness from several inches up to a few feet. However at the 1,500 foot level of the bonanza mines the ore body was 320 feet wide and 900 feet long.

During the 1870's the partnership of Mackay, Fair, Flood and O'Brien held a controlling interest in the capital stock of the two bonanza mines. This partnership was known as the Bonanza Firm. It was the vision and enterprise of these men that was responsible for discovering, developing and producing the ore of the Big Bonanza. Mackay and Fair were experienced mine superintendents. During the bonanza period they remained in Virginia City and directed the operations of the mines.

The Bonanza Firm proved to be a highly profitable partnership. In addition to the bonanza mines the Firm owned and operated a large lumber company, a milling company and the Virginia & Gold Hill Water Company. The organization of the Firm remained unchanged until the death of O'Brien in 1878. Fair withdrew from the partnership in 1881 by which time the Big Bonanza had been exhausted. The total profits of the firm were estimated [Smith, 1943, p.263] to be as follows:

Mackay	$25,000,000
Fair	$15,000,000
Flood	$12,000,000
O'Brien	$10,000,000

A fire broke out in the stopes in 1881 and the firm sealed the mines to cut off the supply of oxygen to the flames. The mines were not reopened until 1884 when Senator John P. Jones contracted to extract low grade ore from above the 1550 foot level. As soon as Jones demonstrated that the low grade ore could be mined profitably Mackay began similar mining operations in the lower levels. In 1886 the Jones' lease was terminated and the newly reorganized Consolidated California and Virginia Mining Company took over all mining operations. During the next eight years $16,447,221 in bullion was produced and the firm paid $3,898,800 in dividends.

Mine Accounting

Very little has been written specifically on the problems of mine accounting. Each mine has internal and external economic factors

which influence its design, its operations and its cost accounting system. However the basic problems of cost finding are the same for a mine as for other industries. These include the determination of the labor, supply and overhead costs of the mine's production. This type of data can be used for the evaluation and motivation of managers and for planning future operations.

The managers of a mining company need to know the cost of producing goods and services. Ore delivered to the surface is the basic product of a mine. To produce this good many services are required. These services include assaying, hoisting, pumping air into the mine, pumping water out of the mine, timbering, and tramming. A supervisor should be placed in charge of each important activity and he should be held responsible for the efficient operation of that unit. This type of information enables the mine's superintendent to evaluate the job performances of his employees.

Portland Mine

The Portland Mining Company had the best mine in the Cripple Creek gold mining district of Colorado. It had yielded $29,430,842 in bullion and paid $8,227,800 in dividends by the end of 1908. This gold deposit was discovered in the early 1890's and was associated with an extinct volcano.

The Portland Mining Company established cost accounts for each service activity. The payroll records were used to charge labor costs directly to these accounts. The supervisor of each department was held accountable for controlling these costs. In addition to accumulating labor costs the service department accounts were charged with the cost of supplies used each month and with distributed overhead costs. The total monthly cost of operating each service department was determined by this procedure.

The service costs were distributed at the end of each month to the development and stoping accounts which represented the two major divisions of mining expense. During the accounting period a separate distribution sheet was maintained for each active opening within the mine (i.e. crosscuts, drifts, shafts and stopes). Labor, supply and allocated service department costs were charged to these distribution sheets. The total stoping expense for a month was equal to the total cost of the distribution sheets for all active stopes. The total development expense was equal to the total of the development distribution sheets. Both development and stoping expenses were closed each month into the mining expense account.

This system has elements of both job order and process costing.

The use of a separate distribution sheet for each shaft, drift, crosscut or stope is a job costing technique. The monthly accumulation of mining costs and the assignment of these costs to the ore sent to the mill, the next operation, is a process costing procedure. At the mill the cost of labor, supplies and overhead used in the milling process were added to the cost of the mined ore to determine the cost of concentrates that the mill produced.

Depreciation and depletion were treated as a distribution of the Portland Mining Company's profits rather than as operating expenses. However the Consolidated Virginia Mining Company charged the costs of equipment and buildings to current operations. Accounting for depreciation and depletion was an unsettled issue during this period [Chatfield, 1977, p.97]. As late as 1939 it was a generally accepted accounting principle to either include or exclude depletion from the cost of mining operations [Fernald, Peloubet and Norton, 1939, pp.114-115].

Comstock Mines

The following discussion of the accounting system of the Comstock mines is based on the company records found in the Consolidated Virginia Mining Company collection of the Special Collections, University of Nevada Reno Library. This collection is quite extensive with 199 bound volumes plus 14 boxes of additional business records.

During the period of the 1870's, the cost accounting system of the bonanza mines changed very little. Because the bonanza was exhausted in less than eight years there really wasn't a great deal of time for the accounting system to evolve. Management was very busy during this period and was likely to make changes only when conditions mandated such actions. If the cost system as it was originally designed proved to be adequate, there would be little incentive to modify it. The mines were small enough so that the superintendents could use personal supervision in place of a detailed cost accounting system.

The richness of the Big Bonanza probably also contributed to the lack of innovation in the cost accounting system. The superintendent of a marginal mine has to monitor costs very carefully to make the mine a successful operation. He is always looking for a new way to reduce costs or increase profits. The manager of a rich mine can afford to have a more casual approach and the bonanza mines were extremely rich. This is not to imply that the mines were poorly run. On the contrary, the evidence indicates that these mines were

models of operating efficiency. However the mines possessed such large deposits of high grade ore that profits were virtually guaranteed. Under these conditions it was natural for the managers to assume that the cost accounting and other management systems were adequate.

Monthly Cost Sheet

The bonanza mines used a monthly cost sheet to provide a classified report of all mining and milling expenses. This report was prepared in conjunction with a statement of cash receipts and disbursements. In this report the monthly expenditures of the firm were classified by such categories as salaries and wages, supplies, milling, assaying, hoisting, freight, office expenses, water, and construction. Data from the cost sheets were used to compile a quarterly report to state and county tax assessors and the annual reports to the corporate stockholders. The average cost of mining a ton of ore and the average cost of milling a ton of ore was determined from the classified expenses of the cost sheets.

The way that various costs are categorized on this report changes from month to month. However there is no discernible pattern to these changes. For example, in October 1873, hardware, wood, lumber and many other items are classified under the general heading of supplies. In September 1874 there are four separate accounts for hardware, wood, lumber and supplies. By April of 1875 lumber and wood are listed as a single account on the cost sheet while hardware has disappeared into the general supplies category.

This system of classifying costs is superior to systems which combine all costs into one or two accounts and to systems which mix revenues with expenditures. However there are a number of primitive aspects in the procedures for accounting for labor costs, supply costs and overhead. The report can be a little misleading since only payments to outside interests are included. The monthly hoisting expense of the Consolidated Virginia consists of the costs of hoisting performed by the Gould & Curry Mining Company but not the cost of operating the Virginia's own hoists. In addition the acquisition cost of land, buildings and equipment is treated as a mining expense in this monthly report. Since all milling was performed by outside firms, this expense should be quite accurate.

The labor costs are the first items reported on the monthly cost sheet. The salaries of the mine superintendent and the mine clerk are listed individually. The remaining labor costs are sometimes reported as a single payroll total. In other months these labor costs

are subdivided to give greater information. For example, in April 1875 the labor costs were reported as follows: $68,738.75 general payroll; $3,845.50 for work on the 1550 foot level, and $325.00 for work on the Latrobe Tunnel.

This appears to be a primitive system of accounting for labor. While it does determine total monthly labor costs, it provides little additional information. The labor costs of the service activities are mixed with the cost of digging development tunnels and breaking ore. The more precise system of the Portland Mine treated the service departments as cost centers.

During the 1870's a large inventory of supplies was maintained at the hoisting works of the Consolidated Virginia Mine. The monthly purchases of supplies for this inventory were included in the cost sheet as a mining expense. Thus the supply costs are not expenses in the modern sense. In addition the costs of these supplies are not allocated to specific cost centers such as the blacksmith and machine shops. Instead supply expenditures are an undistributed subcategory of mining expense.

Another supply inventory was established at the hoisting works of the C&C Shaft. The C&C Shaft was a joint venture of the bonanza mines. Each mine was charged for the actual quantity of materials obtained from this inventory. The mines were also charged for the hoisting performed by this shaft. Any unbilled costs associated with the C&C Shaft were shared equally by the California and Virginia mines. The accounting for this inventory required a perpetual inventory system that could show the exact quantities of the various supplies issued to each mine. For example, during January 1879 the Consolidated Virginia Mine received 23,520 pounds of ice from the C&C inventory while the California Mine received 63,450 pounds at one dollar per pound.

The expenditures associated with operating the mine office in Virginia City are included in the cost sheet's mining expenses. However the cost of operating the corporate headquarters office in San Francisco is not treated as a mining or milling expense and it is therefore not reported on the monthly cost sheet.

The Consolidated Virginia's ore was milled by "independently" owned mills. These mills were independently owned by Mackay, Fair, Flood and O'Brien. The superintendent of the Consolidated Virginia Mining Company paid the mill operators to reduce the ores of the bonanza. The expenditures reported on the cost sheet represent the actual fees charged by these mills to the bonanza mines. The other items on the cost sheet represent mining costs, except for the problem with supply expenditures. Thus this report provides

accurate information on milling costs and an approximation of mining costs for each month.

Labor Efficiency

The daily report was used to monitor the productivity of the mine workers. It was not a cost based report. However since the majority of underground workers earned four dollars per day, labor costs could be estimated from this report fairly easily. This report provided the type of information that could have been used by the mine superintendent to control labor costs, motivate the shift bosses, and evaluate the performance of each shift boss on a daily basis. An example of this report is given in Exhibit 1.

EXHIBIT 1

CONSOLIDATED VIRGINIA MINING CO.
DAILY REPORT

								No. of	No. of Cars	No. of
					January 1st, 1876			Tons Ore	Waste	Men
Surface Hands										118
Assay Department										8
500	feet	Level			New assay office					110
1000	"	"			Latrobe Tunnel					3
1200	"	"								2
1300	"	"								4
						No. of	Cars of	Tons of		
					SHIFT BOSS	Men	Ore	Ore		
1400	"	"	3							
			7							
			11							3
			7		O'Toole	72				
1500	"	"	3		Kelleher	44	210	189		
			11		Odey	28	70	63	252	144
			7							
1550	"	"	3							
			11							
			GOULD AND CURRY			69		113	113	69
			7							
1700	"	"	3							
			11							
							Total		365	454

This particular report describes operations that had not entirely recovered from the fire of October 26, 1875 which devastated much of Virginia City. This fire had destroyed the hoisting works of the Consolidated Virginia Mine, the inventories, the assay office, the Virginia Mill and the California Stamp Mill. Mining operations were greatly restricted for several weeks following the fire. However the hoisting of ore was resumed on December 13, 1875.

On January 1, 1876, most of the mining activities were being conducted on the rich 1,500 foot level. The name of each shift boss is listed along with the following information concerning each shift: the number of workers, the number of cars of ore and waste rock hoisted, and the number of tons of ore hoisted. By means of this report the performance of a shift boss could be properly evaluated in light of the productivity of the men on his shift. The report shows that 113 tons of ore were hoisted through the main shaft of the Gould & Curry Mine. There was a rather large number of surface hands, 118 men. Some of these were probably engaged in constructing the new hoisting works to replace those destroyed two months earlier in the great Virginia City fire. The assay office had also been destroyed in the fire and many of the 110 men employed at the new assay office were undoubtedly construction workers. The 1875 annual report indicated that the new assay office was under construction at the end of the year. The three men stationed in the Latrobe Tunnel and the small numbers stationed on the 1,200, 1,300 and 1,400 foot levels were watchmen.

Milling Efficiency

While the daily report provided a detailed record of the quantity of ore that was mined each period, the company maintained other records that traced the shipment of ore to the various mills in the region. The mine managers were interested in the values as well as the quantities of the ore which were mined and milled. The report of assays provided a daily record of the value and quantity of ore shipped to the various mills of the region. Assays were also made of the tailings and from the underground workings of the mine. In the mill the pulp was sampled hourly and all of the samples were assayed. A record of all of these assays was maintained and comparisons were made between the results [De Quille, 1953, p.236]. The mine's superintendent knew the quantity and estimated value of the ore shipped to each mill. This allowed him to monitor the efficiency of each mill. The milling process normally yielded about 70 to 80 percent of the assayed value of the ore. It was not

economically feasible to extract all of the gold and silver. Each mill's production was expected to exceed 70 percent and if it did not the mill would be accountable.

Post Bonanza Operations

The Consolidated California and Virginia Mining Company was created in 1884 by the merger of the two bonanza mines. This firm extracted low grade ore during the 1880's and 1890's. There are cost sheets from this period which show that the costs of labor and supplies were being distributed between the operations of the shaft and the mining activities in specific levels of the mine. The labor and supply costs of July 1894 operations on the 1,000 foot level amounted to $2,280.34. The monthly cost of operating the shaft was $1,935.38 while nearly $300 was spent to repair the shaft below the 1,100 foot level. This type of detail was not provided by the cost sheets of the 1870's. It represents an evolution toward the detail of the distribution sheets of the Portland Mining Company. The distributed supply costs appear to represent the costs of those items requisitioned each month. This procedure is superior to that demonstrated in the Consolidated Virginia's cost sheets during the bonanza period.

Summary

Significant advances appear to have occurred in the cost accounting practices of underground gold and silver mines between 1870 and 1910. The Comstock mines classified costs as either mining or milling expenditures. The mining expenses were further subdivided into labor, freight, hoisting, lumber, and supply categories. The cost of acquiring land and buildings was treated as a current mining expense. Expenditures were not accumulated and organized in a manner that could help the managers control costs.

By 1910 the Portland Mine was accumulating costs by responsibility centers such as the carpenter shop, the blacksmith shop, the machine shop, the boiler room, the assay office, the hoisting department and the tramming department. The cost of labor, supplies and allocated overhead costs were charged to these service departments. These costs were distributed each month to the two mining accounts, stoping and development. The mining accounts controlled subsidiary distribution cost sheets. There was a distribution sheet for each active opening within the mine. The mining accounts were also charged for direct labor and the direct usage of

supplies. This system provided accurate data on the monthly cost of operations in each stope and tunnel. It also reported the monthly cost of running each service department. This type of data was not being provided by the cost accounting system of the Comstock mines.

This study found evidence which supports the thesis that industrial cost accounting techniques evolved rapidly during the last quarter of the nineteenth century. The cost accounting procedures of the Comstock mines of the 1870's were crude and provided only a limited amount of useful information to the mine managers. The systems employed in the early twentieth century at the Portland Mine provided management with a great deal of useful data concerning the costs of various mining activities.

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